

"Express Mail" mailing label number: EV340866352US

Date of Deposit: March 17, 2004

Our Case No.10541-1949

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
APPLICATION FOR UNITED STATES LETTERS PATENT

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TITLE: Single Wire Control Method For
Electronic Throttle Systems

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BACKGROUND

1. Field of the Invention

[0001] The present invention generally relates to an electronic throttle control system.

2. Description of Related Art

[0002] Electronic throttle control systems for positioning a throttle plate of a throttle body assembly are well known in the automotive industry. These systems typically employ a three phase motor driver within the throttle body itself and use three separate signals for positioning the throttle plate. Typically these signals are a magnitude signal, a direction signal, and a motor driver disable signal, all of which are sent from the controller over three conductors to the motor driver. In general, it is desirable to reduce the number of conductors in a wire harness thereby making the harness more physically robust and more cost effective.

[0003] In view of the above, it is apparent that there exists a need for an improved system and method to communicate within an electronic throttle control system.

SUMMARY

[0004] In satisfying the above need, as well as overcoming the enumerated drawbacks and other limitations of the related art, the present invention provides a system for controlling a motorized throttle. The system includes a controller, a motor driver, a motor, and throttle position sensors. A pulse width modulator is included in the controller to generate a signal to control the throttle. The motor driver receives the signal and manipulates the motor based on the signal. Coupled to the throttle

body assembly, the motor controls the position of the throttle plate based on an output from the motor driver. The signal generated by the controller includes a magnitude component, a direction component, and a disable command component. The magnitude component corresponds to a change in the throttle position. The direction component corresponds to the direction of the change in the throttle position. The disable command component provides the ability to disable the motor. All three components are combined in a single signal.

[0005] In another aspect of the present invention, the duty cycle frequency is based on the magnitude component, the direction component, and/or the disable command component. The signal has first and second duty cycle ranges that correspond to opening or closing the throttle. The specific duty cycle within these ranges correspond to the magnitude component. The disable command component is communicated through a third and fourth duty cycle. While the third duty cycle is higher than the first and second duty cycle ranges, the fourth duty cycle is lower than both the first and second duty cycle ranges. Utilizing the duty cycle encoding described, the signal can be provided from the controller to the motor driver using a single conductor.

[0006] Further objects, features and advantages of this invention will become readily apparent to persons skilled in the art after a review of the following description, with reference to the drawings and claims that are appended to and form a part of this specification.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] Figure 1 is a schematic view of an embodiment of an electronic throttle control system in accordance with the present invention; and

[0008] Figure 2 is a flow chart of an electronic throttle control method in accordance with the present invention.

DETAILED DESCRIPTION

[0009] Now referring to Figure 1, a system embodying the principles of the present invention is illustrated therein and designated at 10. The system 10 generally includes a controller 12, a motor driver 16, a motor 18, a throttle body assembly 19 having a throttle plate 20, and throttle position sensors 24.

[0010] To determine the proper throttle plate position, the controller 12 monitors various vehicle parameters. The controller 12 communicates to the motor driver 16 over a wire harness 13. Previously, such wire harnesses 13 conducted many signals and spanned a distance of many feet. To reduce the number of conductors in the wire harness 13, in the present invention the controller 12 generates a control signal, designated at 14, that includes a magnitude component, a direction component, and a disable command component, all over a single signal conductor. The motor driver 16 receives the control signal 14, interprets the signal 14 to determine the magnitude component, direction component and disable command component and uses these components to drive the motor 18, thereby manipulating the throttle plate 20 into the desired position through rotation of the motor's output shaft 21. The throttle position sensors 24 provide feedback to controller 12 indicating the throttle plate position.

[0011] In one aspect of the present invention, the magnitude component, the direction component, and the disable command component are encoded in the duty cycle of the control signal 14. To achieve this, the controller 12 includes a pulse width modulator 22 that encodes the control signal 14 utilizing four duty cycle

ranges. Although other duty cycle ranges may be used, the various duty cycle ranges are provided herein for the purposes of example only.

[0012] The first duty cycle range and second duty cycle range are used to encode the direction to drive the throttle plate 20. The first duty cycle range is between 1% and 50% duty cycle. If the signal is within the duty cycle range, the motor driver 16 interprets this as driving the throttle plate 20 in an opening direction. The magnitude of torque to drive the throttle plate 20 is based on the specific duty cycle percentage between 1% and 50%. For instance, 40% duty cycle would open the throttle plate more than a 30% duty cycle by controlling the amount of torque to the motor 18. Similarly, if the duty cycle is between 51% and 99%, the motor driver 16 drives the throttle plate 20 in a closing direction by the magnitude of torque pertaining to the particular duty cycle percentage. So that electrical noise will not cause the misinterpretation of the control signal, the duty cycle ranges may have a buffer region at both ends. Final position is determined based on closed loop feedback from the throttle position sensors 24.

[0013] A third and fourth duty cycle, corresponding to about 0% or about 100%, respectively, is used as a disable command signaling the motor driver 16 to turn off power to the plate positioning motor 18. In this situation, the throttle plate 20 goes to a predetermined default position to provide operation of the vehicle in a "limp home" mode. Further, a fault condition could occur if the command from the pulse width modulator was shorted to a battery or ground.

[0014] Now referring to Figure 2, a method for interpreting an electronic throttle control signal is provided. The method start is denoted by block 32. In block 34, the controller 12 begins to pulse width modulate signal 14 to control the throttle

plate position. The motor driver 16 determines if the signal 14 has a duty cycle of 0% or 100%, as denoted by block 36. If the signal 14 has a duty cycle of 0% or 100%, the method flows along line 38 and the motor driver 16 shuts off all power to the motor 18, as denoted by block 40. Further, the throttle plate 20 goes to the default throttle position until the signal 14 from the pulse width modulator 22 is within a valid movement range, as denoted by block 42. As a result, the method flows back to block 36 where the motor driver 16 again determines if the signal 14 is 0% or 100% duty cycle. If the signal 14 is not 0% or 100% duty cycle, the method flows along line 44 to block 46. In block 46, the motor driver 16 determines if the signal 14 is between 1% and 50% duty cycle. If the signal 14 is between 1% and 50% duty cycle, the method flows along line 48 and the motor 18 applies a torque in the opening direction with a force based on the duty cycle percentage as denoted by block 50. Further, when the throttle plate 20 has reached the desired position, based on a throttle position sensor feedback as denoted in block 58, the process flows along line 60 and the throttle plate 20 remains in the desired position until commanded otherwise as denoted by block 62. However, if the throttle plate 20 has not reached the desired throttle position based on the throttle position sensor feedback as denoted in block 58, the method follows along line 64, and the motor 18 applies further torque in the opening direction to open the throttle plate 20 as denoted by block 50.

[0015] Referring back to block 46, if the signal 14 is not between 1% and 50% duty cycle, the method flows along line 52 and the motor driver 16 determines if the pulse width modulator 22 is between a 50% and 99% duty cycle, as denoted in block 54. If the signal 14 is not between a 50% and 99% duty cycle, the method flows

along line 64 and the motor driver 16 re-evaluates the signal 14 in block 36. Otherwise, if the signal 14 is between 50% and 99% duty cycle, the method flows along line 66 and the motor 18 applies a torque in the closing direction with a force based on the duty cycle percentage as denoted in block 68. As shown in block 72, if the throttle plate 20 has reached the desired throttle position based on the throttle position sensor feedback, the method follows line 74 and the throttle plate 20 remains at the desired position until commanded otherwise as denoted in block 62. Alternatively, if the throttle plate 20 has not reached the desired throttle position based on the throttle position sensor feedback, the method flows along line 76 in a feedback loop and torque is applied in the closing direction as denoted by block 68. Further, as denoted by block 62, the method flows along line 78 and the signal 14 continues to be evaluated as denoted by block 36.

[0016] As a person skilled in the art will readily appreciate, the above description is meant as an illustration of implementation of the principles of this invention. This description is not intended to limit the scope or application of this invention in that the invention is susceptible to modification, variation and change, without departing from spirit of this invention, as defined in the following claims.